CLAIMS

1. A direct-current converter comprising:

a first serial circuit which is connected to both ends of a direct-current power supply and in which a primary winding of a transformer and a main switch are serially connected to each other;

a second serial circuit which is connected to both ends of the main switch or both ends of the primary winding of the transformer and in which an auxiliary switch and a capacitor are serially connected to each other;

a rectifying/smoothing circuit configured to rectify and smooth a voltage generated in a secondary winding of the transformer by energy supplied from the primary winding of the transformer when the main switch is turned on, the voltage being rectified and smoothed using a rectifying device and a smoothing device; and

a control circuit configured to turn on/off the main switch and the auxiliary switch alternately using a signal with predetermined switching frequency, wherein

the control circuit reduces the switching frequency during light load.

2. The direct-current converter according to claim 1, wherein

the control circuit includes:

bottom detection means configured to detect a minimum voltage of the main switch after the auxiliary switch is turned off; and

control signal generation means configured to generate a control signal which turns on the main switch at time of the minimum voltage of the main switch based upon an output of the

bottom detection means.

3. The direct-current converter according to claim 1, wherein the control circuit, during further light load, leads to a burst mode where the switching frequency is further reduced.

4. The direct-current converter according to claim 2, wherein the control circuit, during further light load, leads to a burst mode where the switching frequency is further reduced.

5. The direct-current converter according to claim 2, wherein the control circuit includes:

error voltage generation means configured to generate an error voltage signal based upon an error between an output voltage from the smoothing device and a reference voltage;

frequency control means configured to generate a frequency control signal which reduces the switching frequency in accordance with a value of the error voltage signal when a value of the error voltage signal generated by the error voltage generation means reaches a first threshold; and

pulse width control means configured to control a pulse width in accordance with the output voltage and generate a pulse signal which includes the switching frequency reduced in accordance with the frequency control signal generated by the frequency control means, wherein

the control signal generation means generates the control signal based upon the pulse signal from the pulse width control means and the output from the bottom detection means.

6. The direct-current converter according to claim 5, wherein the frequency control means leads to a burst mode where

the switching frequency is further reduced when a value of the error voltage signal generated by the error voltage generation means reaches a second threshold smaller than the first threshold.

7. The direct-current converter according to any one of claim 1, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

8. The direct-current converter according to any one of claim 2, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

9. The direct-current converter according to any one of claim 3, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

10. The direct-current converter according to any one of claim 4, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

11. The direct-current converter according to any one of claim 5, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

12. The direct-current converter according to any one of claim 6, further comprising:

a reactor connected between the primary winding of the transformer and the main switch; and

an auxiliary transformer which is serially connected to the transformer and causes a flux of energy, that is stored in the reactor when the main switch is turned on, towards the secondary winding side when the mains switch is turned off.

13. The direct-current converter according to claim 7, wherein

the reactor includes a leakage inductor between a primary winding and a secondary winding that are wound around the

transformer to be loosely coupled to each other, and

the primary winding of the transformer and the second winding of the auxiliary transformer are wound around a core of the transformer to be closely coupled to each other.